Description of Functional Requirements Diagram – Surveillance Processing

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This document outlines the functions of ASSAP Surveillance Processing as laid out in the diagram below. It is meant to serve as a tool to communicate the pieces of functionality necessary for Surveillance Processing and not as a required architecture. Efforts were made to ensure all ASA Functional Requirements in ASA 3.3.2.1 are satisfied, with the exception of R3.200 which requires assessment of TQL and ACL for each aircraft. The optional Registration Correction function recommended in the ASA MASPS is not being considered.

Inputs

Ownship Info

ADS-B Reports

ADS-R Reports

TIS-B Reports

TCAS – Intruder Info, TCAS – RA
According to DO 185A TCAS II Vol. 2, there are 3 defined Interfaces that feed the TCAS display unit. These include:
1) Intruder Info (1.3.3) – Traffic information including:
    1) Display Arrow – Indication of climbing or descending if vertical rate exceeds 500 ft/min
    2) Relative Altitude – Relative altitude in ft
    3) Range – Range in Nmi
    4) Bearing – Relative bearing in degrees
    5) Bearing OK – Indicates validity of the other aircraft's tracked bearing
    6) Altitude Reporting – Indicates whether other aircraft is altitude reporting
    7) Advisory Code – 0 = Other Traffic, 1 = Proximate Traffic, 2 = Potential Threat, no altitude, 3 = Potential Threat, with altitude, and 4 = Threat. Codes 2 and 3 represent TAs. Code 4 represents a RA.
2) Sound Aural Alarm (1.3.4) – The sound aural alarm interface to the Display Unit indicates the aural alarm condition and whether aural alarms are inhibited. ASSAP does not need to process this message.
3) Resolution Advisory (1.3.5) – Information regarding an RA:
    - Climb RA – The strength of the composite climb advisory if one exists. Values specify the vertical speed limit restriction
    - Descend RA – The strength of the composite descend advisory if one exists.
    - Own Goal Altitude Rate – Gives the recommended escape rate to maintain for safe separation.
    - Combined Control – The value of the combined control state (e.g. No Advisory, Corrective Climb, Corrective Descend, Preventative, Clear of Conflict) used in generating messages and aural alarms.

- Vertical Control – The type of vertical resolution advisory. (e.g. Other, Increase, Crossing, Maintain, Reversal)
- Crossing – Together with Vertical Control, this is used to distinguish between crossing, maintain, and crossing maintain advisories.

Note, the above descriptions do not include any unique traffic identifier. It is assumed that a unique identifier will be implemented in conjunction with the Intruder Info interface for use with ASSAP. It is unclear if a unique identifier is also included in the Resolution Advisory interface. If so, it would be necessary for ASSAP to accept and process Resolution Advisory reports.

Selected Application
The selected application input is optional. It is a necessary input if the Best Source selection logic depends on the selected application.

Surveillance Processing Blocks

Transform into East North Up Coordinates
The WGS coordinates within ADS reports are transformed into range, bearing, and altitude relative to the ownship position and heading.

Target Filter
A filter that removes surveillance reports that are not considered to be a safety risk. This may be necessary to meet processing requirements. The filter is not specified, but should be bound by performance requirements that specify the conditions when reports must be processed. For example, targets that would cause a Conflict Alert warning would be required to be processed.

Associate With Track File
Incoming reports are spatially correlated with previous track files. A Track File is a file for each unique target that contains atleast the mimimum information in Table 3-4 of the ASA MASPS.

Detect Duplicate AC
Detecting duplicate aircraft is necessary when the receiving ADS-B equipment is capable of outputting reports from multiple transmitters that are reporting the same address. While associating a new report to a track file, duplicate targets can be detected when the addresses match, but the spatial correlation fails.

Generate / Update Track File
If the report is determined to be a new unique aircraft and there is enough data to generate a minimum track state, a new track file is generated. Otherwise, the new report data is updated to the track file. If the minimum set of data, as defined in ASA Table 3-4, is not provided, this function is responsible for their determination.

Remove Ownship Shadow
Detect and suppress TIS-B track files that spatially correlate with the ownship position.

Inter-Source Correlation
Spatially correlate and, when possible, match addresses between ADS-B and TIS-B, ADS-B and TCAS, ADS-B and ADS-B (multiple ADS-B links on-board), ADS-R and TIS-B, ADS-R and TCAS,

and TIS-B and TCAS track files.

Select Best Source
If track files are correlated in Inter-Source Correlation, the best source is selected based on the presence of a valid velocity, best integrity for active applications, best position accuracy, and best velocity accuracy, in that order.

If No Velocity, Derive Velocity from Position Reports
If the velocity data is not valid, the velocity is estimated from previous position reports, and an appropriate velocity accuracy is applied depending on the accuracy of the position data and the time difference between reports. If the time difference is either too long or too short, the velocity would be less accurate.

Extrapolate to Next 1Hz Update
At a minimum, extrapolate last measured position to the current update time using velocity. Other methods may be used that do not add any more position error than that introduced by a first order velocity extrapolation.
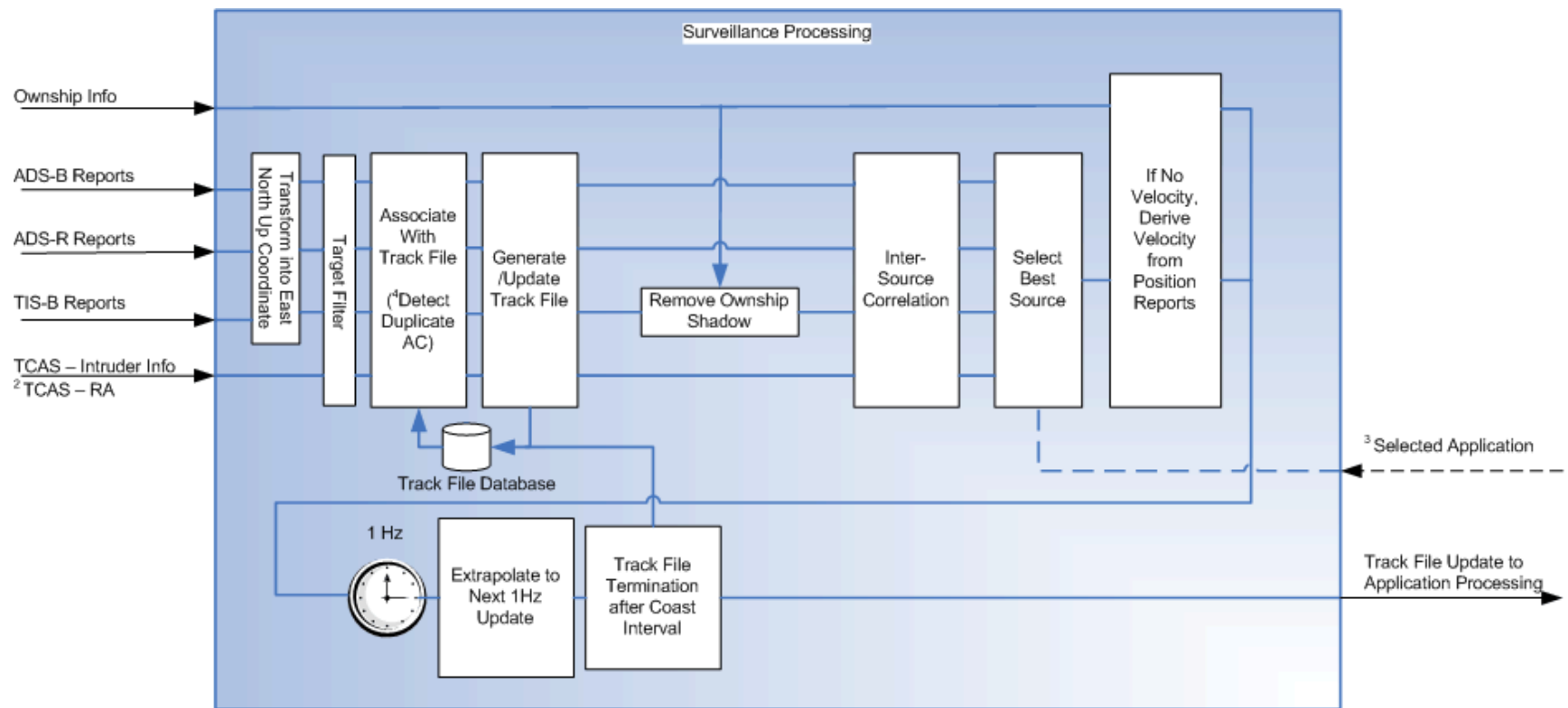
Track File Termination after Coast Interval
Updates are no longer sent to the CDTI after the coast intervals of any parameters in ASA Table 2-3 are exceeded.

Outputs

Track File Update to Application Processing
The update is sent or made available to application processing.

Surveillance Processing

Ownship Info →

ADS-B Reports →

ADS-R Reports →

TIS-B Reports →

TCAS – Intruder Info →
[2]TCAS – RA

Transform into East North Up Coordinate

Target Filter

Associate With Track File ([4]Detect Duplicate AC)

Generate /Update Track File

Remove Ownship Shadow

Inter-Source Correlation

Select Best Source

If No Velocity, Derive Velocity from Position Reports

Track File Database

1 Hz

Extrapolate to Next 1Hz Update

Track File Termination after Coast Interval

[3] Selected Application

Track File Update to Application Processing →

Legend

Shall Block (solid line border)

Should Block (dashed line border)

Notes
1) This order of functional blocks is not required
2) TCAS – Aural Alarm is not included because it cannot be correlated
3) Optional, selected application may affect the way the *Best Source* is determined
4) Detecting duplicate aircraft is required if the ADS-B receiver is capable of outputting reports from multiple transmitters that are reporting the same address.